
# High Performance Computing and Communications at NOAA’s Geophysical Fluid Dynamics Laboratory (GFDL)

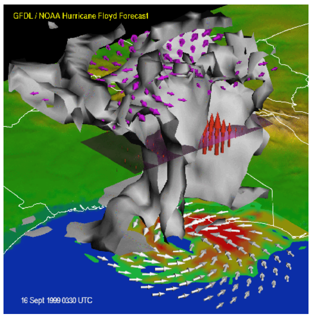
## NOAA Request

In FY 2001, NOAA’s Office of Oceanic and Atmospheric Research (OAR) is requesting an increase of $2.0 million in the Procurement, Acquisition, and Construction (PAC) account to acquire and provide software support for a supercomputer that will provide critical computing, storage and analysis capabilities to scientists at the Geophysical Fluid Dynamics Laboratory (GFDL) in Princeton, New Jersey. FY 2001 is the second year of procurement. $5.0 million was appropriated in FY 2000 for this program, and this year’s increase was included in last year’s budget request. This computer initiative is essential if NOAA is to leverage the world-class research staff and modeling capabilities now in place at GFDL to address important research problems in climate and weather. The computer will be used full-time for developing and testing new and improved models of climate variability, climate change and hurricanes.

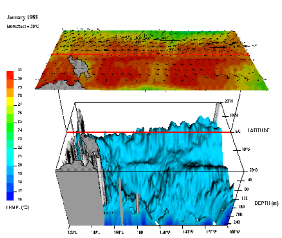
## Background

Since GFDL scientists first developed the coupled ocean-atmosphere climate model in 1969, these models have become the primary tool for predicting and understanding climate behavior on time scales from months to centuries, with NOAA/GFDL research continuing to be at the forefront of this effort. Concerns about long-term climate change and El Niño/La Niña events have spurred demand around the world, including the United States, for the development of national programs to improve climate prediction capabilities. The success of these efforts will depend heavily on physics-based climate modeling and fundamental climate science, two areas in which NOAA/GFDL scientists are among the world’s leaders. Sharp increases in computing and archival capabilities are the remaining ingredient required to allow GFDL scientists to attack the very difficult problems confronting the climate research community and to support ongoing and developing research collaborations within NOAA and with other government agencies, academic institutions and research centers around the world.

A 1998 National Research Council (NRC) report on U.S. climate modeling found that “there is insufficient access to computers powerful enough to take advantage of the U.S. intellectual capability to design and run the climate models needed to answer critical science and policy questions.” The GFDL supercomputer responds to the NRC finding that adequate supercomputing capabilities need to be provided to the climate modeling community in order to optimally use existing scientific capabilities.




GFDL models were used to help track Hurricane Floyd, one of the costliest hurricanes ever to strike the U.S. Scientists work to save lives and minimize the extent of coastal areas that are evacuated as a storm approaches by using GFDL computer models to make more accurate predictions of hurricane tracks.



3-D GFDL illustration of the warming in the Eastern Pacific Ocean that coincides with El Niño events. GFDL computer models can be used to issue advanced warnings of El Niño/La Niña events so that local governments can begin preparing for the potential negative impacts.

## Proposed Actions

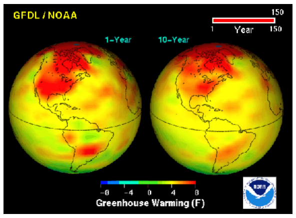
NOAA proposes to support the lease of a high-performance scalable computer system, including very large computing and storage capacity, and the balanced analysis, visualization, and technical support that will be required to make the most effect use of state-of-the-art technology being developed by the American computer industry. NOAA/GFDL have several tangible goals for the new computer system. GFDL plans to develop a more realistic model representation of cloud-radiative feedback in order to improve regional projections of climate change. It will also attempt to identify and evaluate sources of climate "drift" in long-running, higher resolution, coupled climate models, including investigation of the effects of the deep ocean circulation on model behavior. Additionally, scientists will work to develop the next-generation GFDL coupled research model using more realistic physics, higher resolution, and full ocean-atmosphere-soil coupling. This model will be evaluated on its skill for seasonal-to-interannual climate prediction, including its ability to highlight the processes controlling El Niño-Southern Oscillation (ENSO) events. Finally, scientists will pursue the development of a more advanced GFDL Hurricane Prediction System to further improve forecasting accuracy and to provide improved prediction of wind and precipitation fields, storm surge, and changes in storm intensity.

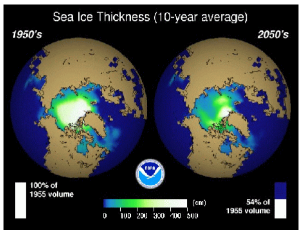
## Benefits

Progress towards resolving any of these problems is of great importance to the Nation, given the potential benefit to the economy of more accurate projections of climate change and better predictions of El Niño events and tropical storms. Advanced warnings of strong ENSO events allow regions to takes steps to mitigate expected negative impacts and save millions in damages. For example, regions expecting severe drought can increase food reserves, and states that anticipate heavy flooding, like California, can work to minimize flood damage by adequately preparing for the increased rain. Also, more accurate projections of climate change are essential to the discussion of appropriate policy measures. A better understanding of natural climate changes will allow scientists to more accurately determine the extent of current human impacts on climate.

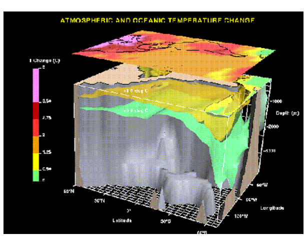
Moreover, improved hurricane predictions will help to save lives and minimize the extent of coastal areas that are evacuated as a hurricane approaches land and will give the areas that will be fully impacted more time to protect property against hurricane damages and to evacuate. Reducing the average length of coastline under hurricane warnings saves at least $1 million per coastal mile in evacuation and other emergency preparedness costs.

Given GFDL's outstanding track record for leveraging its computational resources to produce critical scientific breakthroughs, the funding of this computational increase represents one of the best investments that the Nation can make toward the critical effort to develop improved climate change projections and weather predictions.




These models show the expected rise in surface temperatures (top) and potential for sea ice melting (bottom) resulting from potential global warming scenarios. An increase in global temperatures could result in thermal ocean expansion and sea ice melting that would raise sea levels to the point where many coastal areas, like New Orleans and southern Florida, would be below sea level and prone to flooding.




3-D model showing the expected increases in surface temperature (top panel) and ocean temperature by depth (box) under a $CO_2$-induced warming scenario. Models can be used to predict future changes in climate so that policies can be crafted to curtail potential negative effects.

For more information, please contact Andrew Larkin in NOAA's Office of Legislative Affairs at 202-482-4630.